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S P E C I F I C A T I O N

PROCESS FOR MANUFACTURING A SELF-ALIGNING ANTIFRICTION BEARING AND RACE THEREFOR

To all whom it may concern:

Be it known that I, David G. Toth, a citizen of the United States and a resident of the City of Canton in the County of Stark in the State of Ohio, have invented a new and useful improvement in PROCESS FOR MANUFACTURING A SELF-ALIGNING ANTIFRICTION BEARING AND RACE THEREFOR of which the following is a Specification and for which I pray that Letters Patent of the United States be granted.

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BACKGROUND OF THE INVENTION

This invention relates in general to self-aligning bearings and more particularly to a process for manufacturing an externally self-aligning antifriction bearing and for manufacturing an outer race for such a bearing.

Where shafting is supported by pillow blocks, it is sometimes desirable to use pillow blocks having self-aligning bearings, for these bearings enable the pillow blocks to be mounted without any binding of the shafting. In other words, the bearings of the pillow blocks seek alignment with the shafting that passes through them, even though the housings of the blocks may not be precisely aligned with the shafting.

Pillow blocks are sold with a wide variety of self-aligning bearing arrangements, and the self-aligning characteristics are frequently derived by providing the bearing with a spherical outwardly presented surface that mates with a corresponding surface in the pillow block housing. This of course enables the bearing to pivot universally about a point located along its axis of rotation. Where an antifriction bearing is used, the external spherical surface may either be on the outer race of the bearing or on an inner housing into which the outer race fits.

One pillow block that has found widespread acceptance uses a tapered roller bearing having two rows of tapered rollers oriented in the direct configuration, that is with the large diameter ends of the rollers presented inwardly toward the center of the bearing. The outer race of this bearing is manufactured as two separate components

which are installed over the rows of tapered rollers and then captured within a housing. When so positioned the outer surfaces of the cups possess a spherical configuration.

Traditionally, the outer races for these bearings have been machined from steel tubing. However, machining is, generally speaking, a time-consuming procedure that produces a large amount of scrap in the form of chips. Since bearing steel is quite expensive, the scrap chips represent a significant factor in the overall cost of producing the bearing.

Heretofore, roll forming has been used to produce bearing races, one particularly useful process and machine being disclosed in U. S. patents 3,992,911 and 3,992,914 issued to Formflo Limited of Cheltenham, England. Roll froming offers significant advantages over machining, in that it produces little if any scrap, is quickly performed, and minimizes subsequent finishing operations. In spite of these advantages, roll forming has found commercial acceptance only in connection with races having symmetrical configurations such as those used in common ball bearings. Asymmetrical races, such as the single cups and cones of tapered roller bearings, cannot be rolled without generating force imbalances of a substantial magnitude. Indeed, these imbalances are so great that it is generally difficult to design commercial tooling to tolerate them.

SUMMARY OF THE INVENTION

One of the principal objects of the present invention is to provide a process for producing a roll-formed race that is suitable for use in an externally self-aligning

bearing having rolling elements that are arranged in rows along asymmetrical raceways. Another object is to provide a process for producing a roll-formed race having two rows of rolling elements arranged in the direct orientation. Another object is to provide a process of the type stated for manufacturing the outer race or cup for such a bearing. A further object is to provide a process of the type stated in which the outer race is developed by roll-forming tubing. An additional object is to provide a process for producing a double cup for an externally self-aligning double row tapered roller bearing, which process is less expensive than the conventional machining process. These and other objects and advantages will become apparent hereinafter.

The present invention resides in a process for producing an outer race for an externally self-aligning bearing having two rows of rolling elements arranged in the direct configuration. The process includes deforming a short tube into an intermediate shape having angulated raceways opening out of each end and outwardly presented spherical surfaces at each end, and thereafter severing the intermediate shape into two outer races. The invention also resides in the further step of installing the two outer races over the rolling elements, which encircle an inner race, and holding them in place such that the centers of the two spherical surfaces are essentially located at a common point. The invention also consists in the parts and in the arrangements and combinations of parts hereinafter described and claimed.

DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which form part of the specification and wherein like numerals and letters refer to like parts wherever they occur -

Fig. 1 is an elevational view of a pillow block provided with an externally self-aligning tapered roller bearing manufactured in accordance with the process of the present invention;

Fig. 2 is a sectional view of the pillow block taken along line 2-2 of Fig. 1;

Fig. 3 illustrates the steps of transforming a tubular slug into a double cup for the bearing;

Fig. 4 is a perspective view of the major components of a roll forming machine in which the tubular slug is transformed into an intermediate shape;

Fig. 5 is a sectional view taken through the forming roll and mandrel of the roll forming machine with the tubular slug in it and the forming rolls retracted from the slug; and

Fig. 6 is a sectional view similar to Fig. 5 but showing the slug deformed into the intermediate shape by the forming rolls.

DETAILED DESCRIPTION

Referring now to the drawings (Figs. 1 and 2), the process of the present invention produces an externally self-aligning bearing A that is particularly useful as part of a pillow block B having a housing C, although the bearing A has utility in other applications as well. The bearing A has an axis X, but inasmuch as the bearing A is self-aligning,

this axis X is not fixed with respect to the housing C which is usually bolted down firmly against a supporting structure. As a consequence, the bearing A will align with a shaft that is extended through it, even though the pillow block housing C may be somewhat out of line with the shaft. To appreciate the process by which the bearing A is formed requires an understanding of the bearing A and the housing C which together form the pillow block B.

The bearing A basically includes (Fig. 2) a cone 2, cups 4 that surround the cone 2, tapered rollers 6 that are arranged in two rows between the cone 2 and cups 4, cages 8 for maintaining the correct spacing between the rollers 6, there being a separate cage 8 for the rollers 6 of each row, and seals 10 which close the annular spaces between the cone 2 and cups 4 at the ends of the bearing A.

The cone 2 contains a bore 12 (Fig. 2) that extends completely through it for accommodating a rotating shaft. On its outwardly presented surface the cone 2 has a pair of raceways 14, a thrust rib 16 that is located between the raceways 14, and extended retaining ribs 18 at the opposite ends of the raceways 14. The raceways 14 taper down toward the retaining ribs 18, so that the large diameter ends of the raceways 14 are located at the thrust rib 16. The retaining ribs 18 have outwardly presented cylindrical surfaces that project axially beyond the ends of the cups 4.

The tapered rollers 6 (Fig. 2) are arranged in two rows, there being a separate row around each cone raceway 14.

The side faces of the rollers 6 of course contact and roll along their respective raceways 14 with their large diameter ends against the thrust rib 16. Therefore the rollers 6 are in the direct orientation.

The cages 8 (Fig. 2) not only maintain the correct spacing between the rollers 6 of each row, but further co-operate with the retaining ribs 18 on the cone 2 to prevent the rollers 6 from falling off of the cone 2 in the absence of the cups 4. Indeed, the cone 2, the rollers 6, and the cages 8 are sold as a unit which is known as a double row cone assembly 20.

The cups 4 (Fig. 2) surround the cone assembly 20 and each includes an inwardly presented raceway 22, there being a different cup 4 and raceway 22 around each row of rollers 6. Indeed, the side faces of the rollers 6 contact the cup raceways 22, just as they contact the cone raceways 14. In this regard, the tapers of the raceways 14 and 22 are such that they present the rollers 6 of the two rows on apex. This means that the conical surfaces of the rollers 6 of either row, if extended to their respective apices, will have those apices located at a common point along the axis X of rotation for the bearing A. Hence, during operation of the bearing A pure rolling contact exists between the rollers 6 and the raceways 14 and 22 between which they are confined.

Each cup 4 also has a spherical outwardly presented surface 24, the center Y (Fig. 2) of curvature for which is along the axis X midway between the two rows of rollers 6. In other words, the center Y of curvature for the surface 24

is at the center of the bearing A. While the surface 24 of each cup 4 is spherical, it does not occupy a full sphere, but instead terminates at a short tubular extension 26 which projects axially beyond the small diameter end of the raceways 22 for that cup 4 and encircles one of the retaining ribs 18 on the cone 2.

The seals 10 close the annular spaces between the cup extentions 26 and the cone retaining ribs 18. Each seal 10 includes a seal case that is pressed into the end of one of the cup extentions 26 and an elastomeric seal element which contacts the underlying retaining rib 18.

The pillow block housing C, which receives the bearing A, includes (Figs. 1 and 2) a base 30 and a cap 32, both of which are preferably steel castings. The cap 32 is secured to the base 30 by machine screws 34 such that the bearing A is captured between them, yet can pivot relative to the block housing B about the center of the curvature Y for the spherical surface 24. In this regard, the base 30 and cap 32 when bolted together provide an inwardly presented spherical surface 36 which is substantially equal in radius to the spherical outer surfaces 24 of the cups 4. The surface 36 is machined, and like the surfaces 24, it is not a full sphere, but is instead abbreviated, being cut off to even a greater extent than surfaces 24. Moreover, the parting plane between base 30 and the cap 32 passes through the center of curvature Y for the surface 36. Hence, when the cap 32 is removed, the bearing A may be dropped into the base 30 where its spherical cup surfaces 24 will mate with the portion of the surface 36 that is within the base 30. Of course, when the cap 32 is placed over

and bolted down against the base 30, the remaining portion of the spherical surface 36 is extended over the cup surfaces 24, and the cups 4 as well as the entire bearing A is captured within the block housing C. In addition, the base 30 of the block housing C has wings 38 which project laterally and contain bolt holes 40 through which bolts may be extended for clamping the pillow block B against a supporting surface.

Since the bearing A has its rollers 6 arranged in the direct orientation, that is with the large diameter ends of the rollers 6 presented toward the center of the bearing A, the cups 4 cannot be installed over the cone assembly 20 as a unitary double cup. Instead, they must at the time of assembly be two separate components which are passed over the opposite ends of cone assembly 20 and brought together around the cone assembly 20. Basically, the cups 4 are derived from a short tube of bearing steel which is rolled into a configuration or shape that is essentially the reversal of the pair of cups 4 in the assembled bearing. This single shape is then parted midway between its ends and the two halves or single cups which are obtained are reversed in position with respect to each other and passed over the ends of the cone assembly 20, whereupon the bearing A is captured within the block housing C.

More specifically, to manufacture the cup 4, a short tube slug 50 (Fig. 3a) is parted from a longer length of steel tubing, but before the parting operation, the inside and outside surfaces may be machined so that they are free of all scale, as well as distortions and other imperfections.

This machining removes very little metal, so that the tube slug 50 has essentially the same inside and outside diameters as the tube stock from which it was derived. In this regard, the tubing stock is cylindrical, and the tube slug 50 likewise has cylindrical inner and outer surfaces. The steel of the tube stock is high quality bearing steel.

The tube slug 50 is next roll-formed, while normally at ambient temperature, into a tubular intermediate shape 54 (Fig. 3b) which on its inwardly presented surface has the two cup raceways 22. In addition, the intermediate shape 54 has two outwardly presented spherical surfaces 24, there being a spherical surface 24 located directly outwardly from each cup raceway 22. The raceways 22 taper downwardly toward the center of the intermediate shape 54 and have their large diameter ends at the ends of the shape 54. Those ends are generally squared off with respect to the axis X and as to the raceways 22 they function as cup front faces 58. In this regard, the back or backing face of a cup for a simple single row tapered roller bearing is the face through which the thrust loading are transferred and is opposite the front face. The spherical surfaces 24 lead up to the front faces 58 where the intermediate shape 54 has its greatest diameter.

Between the small diameter ends of each pair of spherical surfaces 24 and raceways 22 is a connecting section 60 (Fig. 3b) of essentially cylindrical configuration. Indeed, the small ends of the spherical surfaces 24 merge into the outside surface of the connecting section 60 where the

diameter of the connecting section 60 equals that of the small ends of the spherical surfaces 24. Likewise, the small ends of the tapered raceways 22 merge into the inside surface of the connecting section 60 where the inside diameter of the connecting section 60 is that of the small ends of the raceways 22. In short, the inside and outside diameters of the connecting section 60 correspond to those of the tubular extensions 26 on the completed cup 4. However, the connecting section 60 is slightly greater than twice as long as either of the tubular extensions 26.

The machine in which the intermediate shape 54 is roll-formed includes (Figs. 4-6) a rotatable split mandrel 62 having two mating sections 64 and 66 which when together provide an outwardly presented surface that corresponds to the inwardly presented surface of the intermediate shape 54. However, the two sections 64 and 66 may be withdrawn axially from each other a distance sufficient to enable the tube slug 50 to be inserted between the two sections 64 and 66.

Hence, when the two sections 64 and 66 are urged together by hydraulic or pneumatic means or by the use of springs the tube slug 50 is captured between them (Fig. 5). In this regard, the tube slug 50 is constrained between the outside surfaces of the mandrel section 64 and 66 over which the slug 50 fits, thus insuring that the slug 50 is axially and radially aligned with mandrel 62. Moreover, the slug 50 contacts the mandrel sections 64 and 66 only at its ends for the sections 64 and 66 in combination are configured to provide an annular depression between the ends of the slug 50. This depression possesses the

configuration of the inside surface on the intermediate shape 54 (Fig. 6).

In addition to the mandrel 62, the rolling machine 52 includes a pair of forming rolls 68 and 70 (Figs. 4-6) which as to the mandrel 62 that is between them are located 180° with respect to each other. Moreover, the roll 68 is fixed in position, while the roll 70 is moveable toward and away from the mandrel 62 and the roll 68. The periphery of each roll 68 and 70 in terms of contour, corresponds to the outside of the intermediate shape 54 (Fig. 6). The machine 52 also includes supporting rolls 72 that are located 90° with respect to the forming rolls 68 and 70 and are further capable of being advanced toward or retracted from the mandrel 62. The cross-sectional configuration of supporting rolls 72 at their peripheries generally corresponds to that of the forming rolls 68 and 70. The supporting rolls 72 along with the mandrel 62 are mounted on a floating table which is free to move in the same line of travel as the movable roll 70.

To transform the tube slug 50 into the intermediate shape 54, the movable forming roll 70 is retracted from the fixed forming roll 68, and likewise the two supporting rolls 72 are retracted from each other. Also the mandrel sections 64 and 66 are withdrawn axially from each other. The tube slug 50 is placed between the two mandrel sections 64 and 66, which are then urged together to constrain the slug 50 between them (Fig. 5). Next the movable forming roll 70, while rotating, is advanced toward the fixed roll 68, which also rotates, and the supporting rolls 72 are

are likewsie advanced toward the tube slug 50. The rotation of the forming rolls 68 and 70 is imparted to the tube slug 50, whereupon the movable roll 70 is urged against the tube slug 50 with a considerable amount of force. In effect, the tube slug 50 is compressed between the peripheral surfaces of the two forming rolls 68 and 70 with sufficient force to deform the slug 50 as it revolves between the rolls 68 and 70. On its outside surface the slug 50 assumes the contour that is on the periphery of the forming rolls 68 and 70 (Fig. 5). The inside surface of the slug 50 also deforms, and in so doing assumes the shape on the outside of the mandrel 62.

During the roll-forming the metal of the slug 50 is displaced axially away from the midportion of the slug 50 which is preferable to displacing the metal in the opposite direction. Moreover, the midportion between the ends of the slug 50 is reduced in diameter so as to fill the initial annular space between the midportion and the outside surface of the mandrel 62. Furthermore, both the slug 50 and the shape 54 which is derived from it are symmetrical about their midportions so no unbalanced forces in the axial direction develop during the roll-forming. Also, the spherical surfaces 24 are rolled to substantially their final size with little to no subsequent grinding or polishing required.

After the intermediate shape 54 is fully formed, it is removed from the roll-forming machine and parted midway between its front faces 58 (Fig. 3d), that is within connecting section 60, to provide two identical single cups 74, each having an inwardly presented raceway 22, and outwardly presented spherical surface 24, a front face 58 at

the large diameter end of its raceway 22, and a tubular extension 26 at the small diameter ends of the surfaces 22 and 24.

Thereafter, the two cups 74 are reversed in position so that the front faces 58 of the cups are presented toward each other. Thereupon, the cups 74 are advanced over the ends of the cone assembly 20, with their large ends leading, and are brought together, in which case the front faces 58 of the two single cups 74 abut or are in close proximity (Fig. 3d).

Next, the completed bearing is dropped into the base 30 of the pillow block housing C so that the spherical outer surfaces 24 of its cups 4 are against the portion of the spherical inner surface 36 that is in the base 30. The cap 32 is placed over the base 30 and secured with the bolts 34, its portion of the spherical inner surface 36 likewise being against the spherical outer surfaces 24 of the cups 4. This completes the pillow block B.

When the two single cups 74 are so disposed and captured within the housing C the cup raceways 22 lie along and contact the side faces of the tapered rollers 6 and the bearing construction has the proper setting. Also, the two spherical surfaces 24 match to form a single spherical surface which closely conforms to the inner spherical surface 36 of block housing C.

This invention is intended to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure which do not constitute departures from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A process for producing a two part outer race for use in an externally self-aligning tapered roller bearing having two rows of tapered rollers in the direct orientation, said process comprising deforming a short tube into an intermediate shape having an inwardly presented tapered raceway opening out of each end and an outwardly presented spherical surface near each end; and severing the shape intermediate its ends into two single cups, each having a raceway and a spherical surface thereon.

2. The process according to claim 1 and further comprising bringing the two single cups together at the large diameter ends of their tapered raceways in reverse orientation to that when formed to provide a two part outer race in which the two spherical surfaces are equal in radius and have a common center.

3. The process according to claim 1 wherein the slug is deformed into the intermediate shape by roll-forming.

4. The process according to claim 1 wherein the outwardly presented spherical surface is rolled substantially to final size with little to no subsequent grinding or polishing required.

5. The process according to claim 1 wherein the step of deforming the slug into the intermediate shape comprises placing the short tube over a rotatable mandrel, the outwardly presented surface of which has the configuration of the inwardly presented surface of the intermediate shape, rotating the mandrel and the short tube that is upon it, and forcing at least one forming roll against the outwardly presented surface of the short tube, the cross-sectional configuration of the forming roll at its periphery being the same as that for the outwardly presented surface of the intermediate shape, whereby the inwardly presented surface of the tube transforms into a surface corresponding to that of the outwardly presented surface of the mandrel and the outwardly presented surface of the tube transforms into a surface corresponding to the cross-sectional configuration of the roll at the periphery of the roll.

6. A process according to claim 5 wherein the mandrel is split into sections which can be withdrawn from each other along the axis of rotation to free the intermediate shape from the mandrel.

7. A process for producing an externally self-aligning bearing having two rows of rolling elements arranged in the direct orientation, said process comprising deforming a short tube into a tubular intermediate shape having an inwardly presented raceway opening out of each end and an outwardly presented spherical surface leading up to each end, each raceway being angulated and having its greatest diameter toward the end out of which it opens, each spherical surface having its greatest diameter presented toward the end up to which it leads; severing the intermediate shape intermediate its ends to produce two single row outer races, each having a raceway and a spherical surface thereon and also a front face at the large diameter ends of the raceway and spherical surface; installing each cup over a single row of rolling elements that surrounds an inner race; and securing the outer races with their front faces adjacent to each other and with their spherical surfaces having essentially a common center.

8. The process according to claim 7 wherein the short tube is deformed into the intermediate shape by roll-forming.

9. The process according to claim 7 wherein the inner race is a unitary structure having two rows of rolling elements arranged about it.

10. The process according to claim 7 wherein the rolling elements are tapered rollers.

DEFENSIVE PUBLICATION

ABSTRACT ~~OF THE DISCLOSURE~~

An externally self-aligning tapered roller bearing, which is particularly useful in pillow blocks, utilizes a conventional double row cone assembly, the rollers of which are in the direct orientation. The cup, however, is derived from a tubular slug which is roll-formed into an intermediate shape having inwardly presented raceways opening out of each end and an outwardly presented spherical surface leading up to each end. The intermediate shape is severed intermediate its ends into two single cups, each having a tapered raceway, a spherical surface, and a front face at the large diameter end of its raceway. The two single cups are thereafter reversed in position such that the front faces are opposed, and installed over the double row cone assembly, with each cup surrounding a different row of rollers on the cone assembly. The two cups are then confined within the pillow block housing with their front faces in abutment or in close proximity. The bearing assembly which is thereby formed has the centers for the two spherical surfaces essentially located at a common point along the axis of rotation for the bearing.